THE ADVANTAGES OF PRGRAMMABLE LOGIC CONTROLLERS IN INDUSTRIES

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Abstract

In the industrial world the computers and microprocessors have become popular for use in automatic control systems, thus we have a new generation of control systems which is called Programmable Logic Controller . These systems has plenty of control components (Timers, Counters, Registers, Comparator, Clock, …)inside the software of the PLC instead of the classical components , and the contacts of the relay (Normal open and Normal close) have been replaced by the orders which are saved in memory. The updating and modification of the system is easy to obtain by rewriting the program.Another advantage of the PLC is that the input of the PLC is photo isolated and shielded , but the most important advantage is that we can test the program befor it's using in the machine by using the simulator which is included with the PLC program .

Keyword: Programmable Logic Controller , Ladder Language , Function Black Diagram , Structured Text , Insturction List , secquential Function Chart .

محاسن التحكم المنطقي المبرمج في الصناعه

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الخلاصه

في السنوات ألأخيرة شاع أستخدام الكومبيوترات والمعالجات المصغرة في أجهزة التحكم ألأوتوماتيكي و نتيجة لذلك ظهر جيل جديد من أجهـزة التحكم ألأوتوماتيكي والتي تسمى أجهزة التحكم المنطقي المبرمج والتي تمتاز بأنها تحتوي بـداخلها علـى عـــدد كبير من عناصر التحكم (المؤقتات ، العدادات ، مسجلات ألأزاحه ، المقارنات ، عناصر التوقيت ،.....) وكـذلك ملامســـات الريليات تم استبدالها بأوامر مخزنه مسبقا مما أتاح لنا أمكانية ألاستغناء عن ريليات التحكـم التي كنـا سابقا نستخدمها في لوحـات السيطرة القديمة. تعديل البرنامج وتغييرة أصبح أسهل من السابق و ذلك بأعادة كتابه البرنامج من جديد ، ونتيجه للعزل الضوئي والتغليف المحكم تم تقليل الخسائر ، ولكن من أهم محاسن أجهـزة التحكـم المنطقـي المبرمج هو أمكانيه فحص البرنامج الخـاص بالماكنه قبل تشغيله عن طريق المحاكي المرفق مـع برمجيـات الجهـاز وبذلك أصبح بأمكاننا أضافه أو أزاله أي عمليه عن طريق تغيير البرنامج وكذلك في حاله حصول عطل ما يمكنـنا أعـادة تحميل البرنامج من خلال البرنامج المخزن على قرص مضـغوط بعد عمليه كتابه البرنامج .

Introduction

PLCs are used in many different industries and machines such as conveyor systems , Food processing machinery (e.g filling bottles with water or juice) , Auto assembly (e.g auto Industry), Fluid level control (e.g water tanks) , Mixing fluids (e.g paint Industries) , Motor Speed Control (Sanjeey Gupta &SC Sharma**, 2005)** . Well known PLC brands are Allen-Bradley , Mitsubishi-Electric , ABB Ltd, Honeywell , Siemens , Modicon , Omron , General Electric , Square-D (Telemecanique) and Panasonic (a brand name of Matsushita) , Less known PLCs that are programmable in BASIC are available from CUBLOC(Com File Technology) or TRI-PLC (Traingle - Research Int.) (Nebojsa Matic , 2001- PLC encyclopedia - PLC References , 2004) . The primary reason for designing the PLCs is to eliminate the large cost involved in replacing the complicated relay based machine control systems .
The first PLC which is used in commercial production was named MODICON – 084 proposed by Bedford associates , Then other companies proposed computer based schemes (PDP-8) . When production requirements changed so did the control systems , this becomes very expensive when the change is frequent.
The PLCs had to be :
* Easily programmed by maintenance and plant engineers.
* The lifetime must be long .
* The programming changes easily performed.
* The use of programming technique (that replace mechanical parts with solid-state once) .
* The use of microprocessors and CPU units .
* Can send and receive varying voltages to allow us to enter the analog world.

(Mohammad Aqil , 2007 - Nebojsa Matic , 2001 – Imad AlSai'ad , 2005) .

The program is a chain of instructions held in order to control the working procedure of a machine or a system, Writing the instruction of the program will be held by one of the languages especially made to the PLC ' by using the programs especially made to the PLC according to the manufacturing company , There are five basic languages :

1) Function block diagram (FBD) .

2) Ladder language (LD) .

3) Structured Text (ST -similar to Pascal programming) .

4) Instruction list (IL) .

5) Sequential Function Charts (SFC).

(Lipsky .Kevin , 1990 - PLC Languages)

After the writing of the program in one of the languages we sent this program from the personal computer to the memory in the PLC , this procedure contains translating the instructions to the machine

language by using the compiler listed with software of the PLC. The language which is used in this research is LADDER language (LADDER Logic Training Series , www.Automation Nc .com) .

Experimental Validation

In this item we will consider Zelio SR1-B201BD (PLC) by Telemecanique :

1) From Edit menu we select the Zelio Mode , in this menu we can choose the language (Ladder) and logic inputs { 12 separate inputs } , output { 8 outputs every output has 4 conditions (Q - contactor , Q - remote control , SQ - set , RQ- reset)} , intermediate cell , timers , counters , analog inputs , clock , text element .
2) From Edit menu we select the Free Mode ,In this menu we can choose the Program , Parameters , Simulation .
3) Transfer menu: in this menu we can choose PC- Modul {downloading program from PC to PLC } , Modul – PC (downloading program from PLC to PC) , Run Modul (run the PLC) , StopModul (stop PLC) .
4) Mode menu: in this mode we can choose On line Monitoring Mode(Here the PLC is connected to the PC through the programming cable we can watch the performance of the PLC through the screen of the computer, Editing Mode (when we want to disconnect the PLC from the PC) .

Case Study :

A juice machine which works totally mechanical and we need to modify it so the control system will be electrical , Since relays , limit swiches are mechanical devices they also have a limited lifetime which required adequate maintenance schedules, troubleshooting was also quite tedious when so many relays are involved , also the size is important and the initial wiring.The machine shown in **(Fig . 1)** that works during the week { from Saturday to Thursday }and the working time is form 8:00 to 13:00 and from 13:30 to 16:00 . The machine wash a bottle with water through valve V1(opens for 2 sec) ,then the machine full the bottle with juice through valveV2 (opens for 4 sec), for each valve there is a sensor (S1) , (S2) respectively , after counting 12 botlles the machine stops ?

Working Procedure

When the bottle is at point A **(Figure 1)** and we press the start switch the motor now will work , when the bottle reach the sensor S1 the motor will stop and the valve V1 will work for a period (2 sec) then the motor will work until the bottle reach sensor S2 then the motor will stop again and valve V2 will work for a period (4 sec) then the motor will work , and so on……

The electrical and PLC wiring is shown in **(Figure 2).**

Logic Form

(Motor = 1) ….. {(Start=1) ANDA (S1=1) ANDA (S2=1)} OR {(Start = 1) AND (TW1.Out =1) AND (S1= 1)} OR {(Start =1) AND (TW2.Out =1) AND (S2=1)}.

(Motor = 0)….. (Start=0) OR {(Start = 1) AND (S1=1) AND (TB1.Out =1)} OR {(Start =1) AND (S2 = 1) AND (TB2.Out =1)} .

The LADDER diagram will be as in **Figure 3** .

Now if we would like to control the switching time of the machine during the week (from Saturday to Thursday) so that the working time begins (8:00) until (13:00) and form (13:30) until (16:00) so we must activate the clock from the tool bar (Edition) of Zelio , here we have four channels (canal A,B,C,D) as in the window below, by turning the power on (on) the Zelio PLC will run every day except Friday as in **(Figure 4)** . So if we have an emergency case or we need to stop the machine all we have to push the button (Halt) as in (**Figure 5)** .The Ladder Diagram will be the same as Fig . 3 but it will have additions as in (**Figure 6) .** Now if we need the machine to stop after counting 12 bottles **(Figure 6)** ,we have to add a counter (up) fixed on (12) and sensor(S3) , the machine will start if we press the start and it will stop at sensor S1 for (2 sec.) then it will run until it reach sensor S2 the Motor will stop for (4 sec.) and the motor will run again until the counter counts (12) bottles and the motor will stop after that so the worker can remove the package of a dozen of bottles , then he will start the machine again (**Figure 7)**.

Logic Form

(Motor = 1) ….. {(Start=1) ANDA (S1=1) ANDA (S2=1)} OR {(Start = 1) AND (TW1.Out =1) AND (S1= 1)} OR {(Start =1) AND (TW2.Out =1) AND (S2=1)} OR {(Start = 1) ANDA (Counter. Out =1) ANDA (Stop = 1)} .

(Motor = 0) ….. (Start=0) OR {(Start = 1) AND (S1=1) AND (TB1.Out =1)} OR {(Start =1) AND (S2 = 1) AND (TB2.Out =1)} OR (Counter = 1) .

The total electrical wiring will be as in **(Figure 8)** and LADDER diagram as in **(Figure 9)** .

Results And Discussion

By using PLC we have minimized the large number of electrical components (timers ,counters , clock) which can be used in the control panels and maintenance time and increase the life time of machine and the speed of processing (using CPU) so if we need to add or modify the procedure of work all we need is to rewrite the program in its new form in one of the languages of programming and reload it to PLC by using personal computer while the old method (using electrical components) needs to modify the control panel (adding new components and new design) which will add extra costs and extra time .

Conclusion

1. By using the PLCs we can have an adequate design to install the control components, time of installion, time of modification, time of maintenance.

2. All kinds of PLCs have the same procedure of work but they don't have the same number of component which contains, type , reading – writing speed , response speed , number of inputs – outputs , number of jobs which PLC can operate , capacity so the user must know the specification of these types in order to choose the adequate PLC .

3.The classical structure (hardwire logic) is based on different kinds of component (wires , timers , counters) and it's a solid state and inflexible and has many disadvantages such as repairing a control panel which can take a lot of time to find the broken part and even it take a lot of money, when we need to modificate the procedure of the machine.

4. In order to change the procedure of a machine we have to renew the program (adding timers , counters and other applications which can the PLC apply) .

5. The PLC s are designed to a different industrial overloads and temperature and they are protected from Jamming , and against short circuit.

6. In case of program overloaded we can recharge the program(loaded on a CD) from the PC to our PLC by using the transfer – PC module in the tool bar of the device .

7. We can test the program before installing the PLC on position by using the simulator(which is placed in edition mode - Free mode in the tool bar of the device) enclosed with the PLC.

8. This kind of PLCs called (Compact) and there are two kinds of PLCs more (Modular, Intermediate) but this kind has the advantage in case we have several machines so if one machine is out of order there is no need to stop all the machines only the broken one , and this kind of PLCs has the ability to add LOCAL EXPANSION which incraes the number of inputs and outputs without the need to buy a new PLC , also we can connect this kind of many of these PLCs with our PC or with an external mointer through the Net input .

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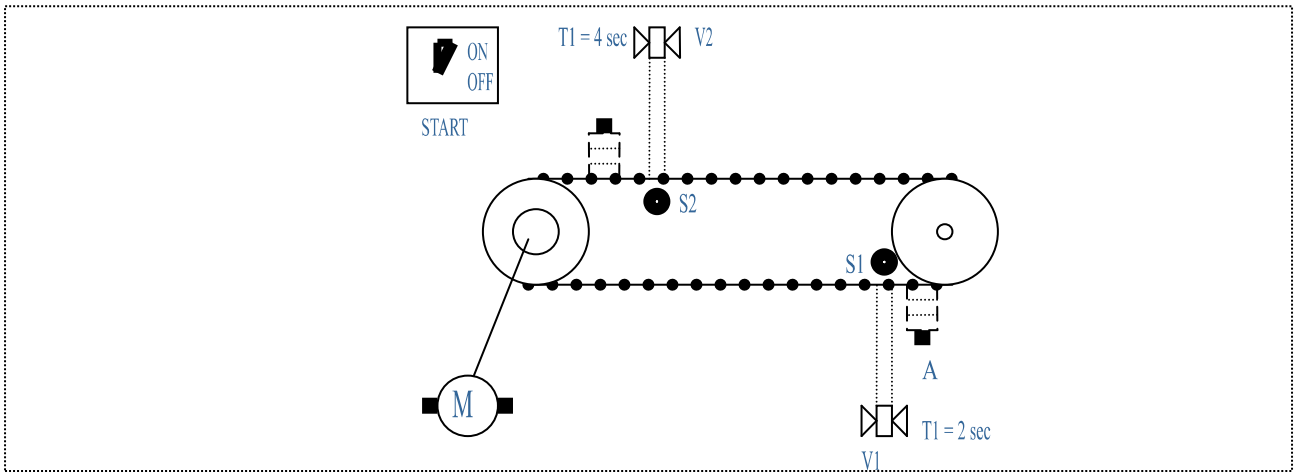
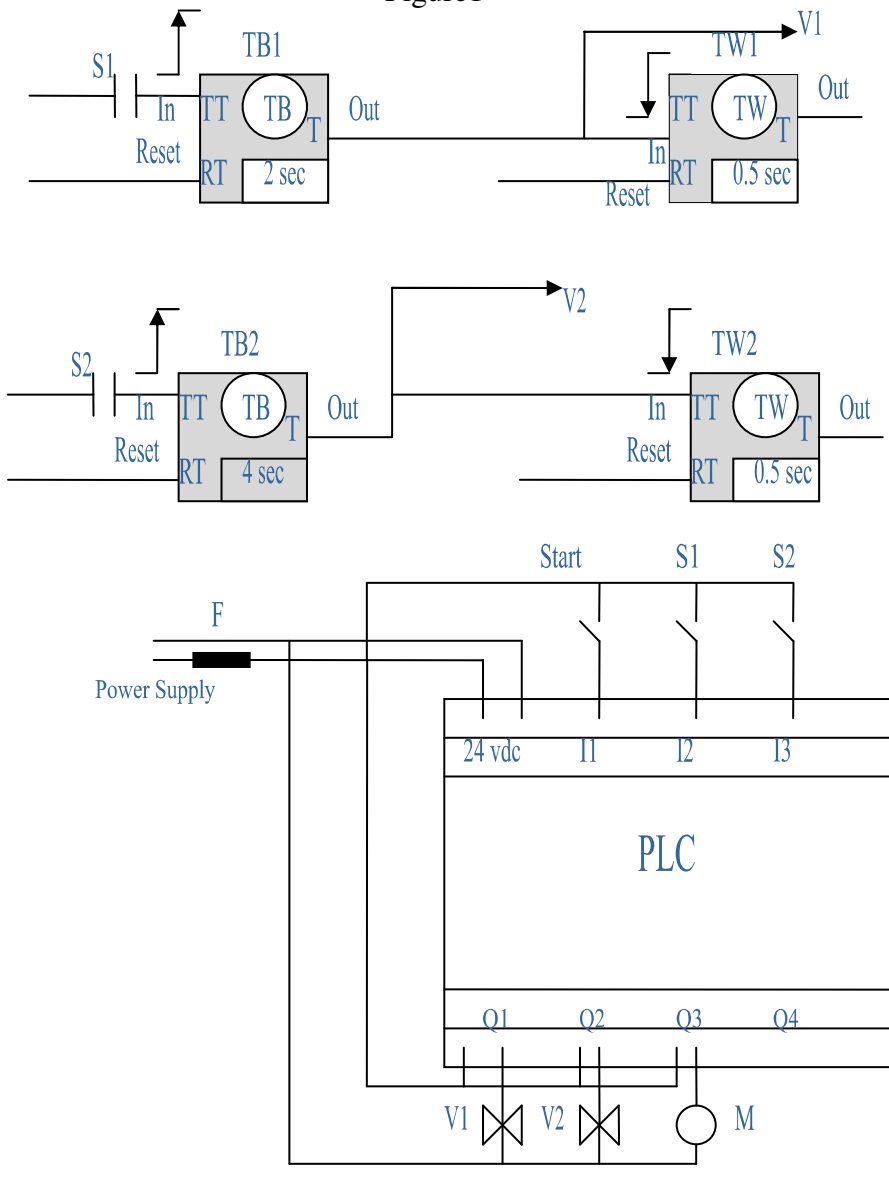


Figure1



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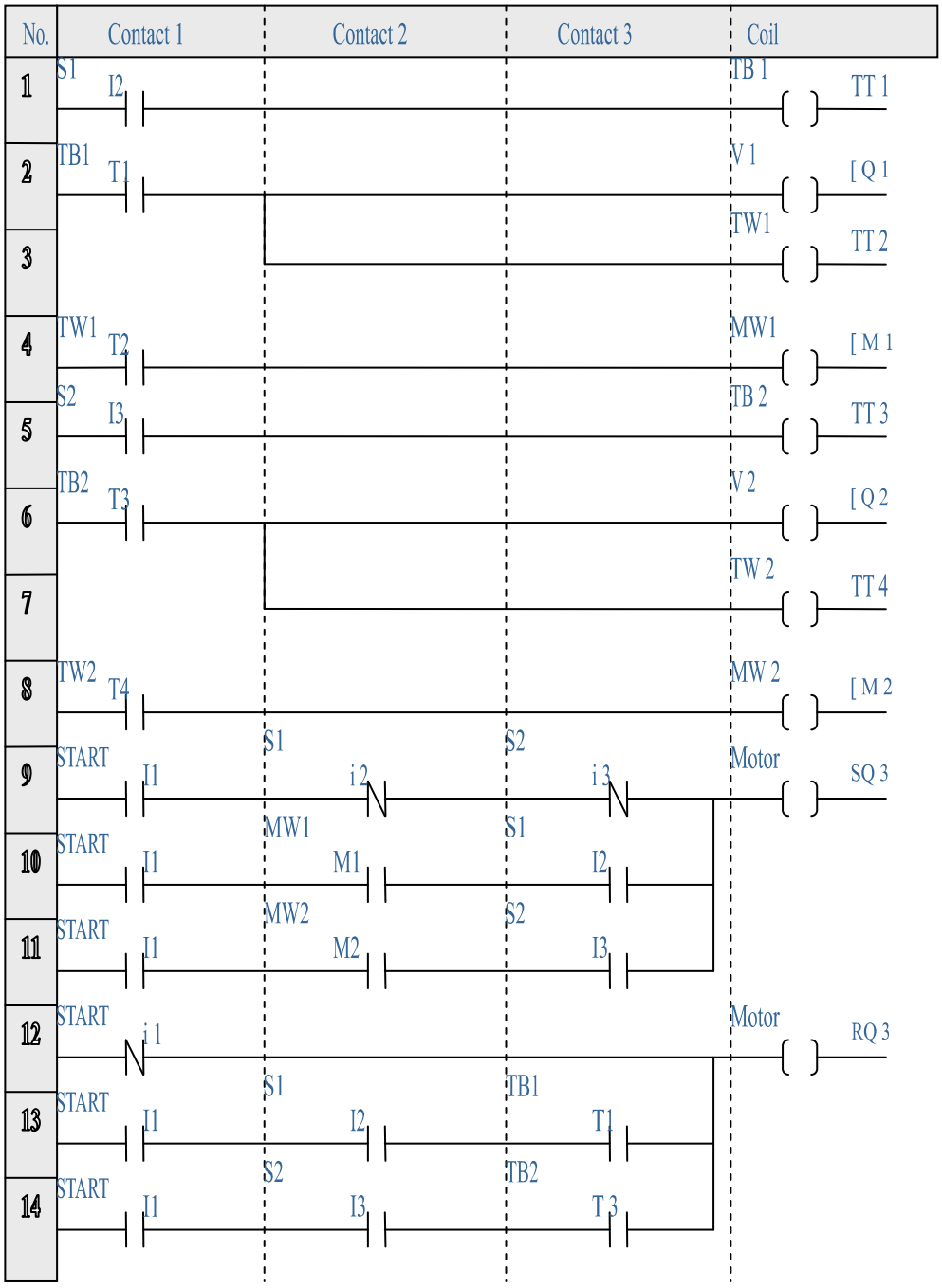
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Contact 1
Contact 2
Contact 3
Coil
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S1
I2
TB 1
TT 1
2
TB1
T1
V 1
[Q 1
3
TW1
TT 2
4
TW1
T2
MW1
[M 1
5
S2
I3
TB 2
TT 3
6
TB2
T3
V 2
[Q 2
7
TW 2
TT 4
8
TW2
T4
MW 2
[M 2
9
START
I1
S1
i 2
S2
i 3
Motor
SQ 3
10
START
I1
MW1
M1
S1
I2
11
START
I1
MW2
M2
S2
I3
12
START
i 1
Motor
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14
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I1
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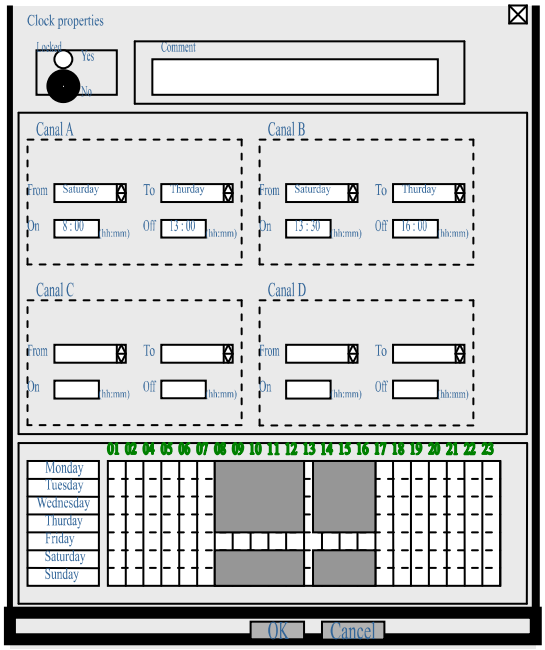
I3
TB2
T 3

Figure 3



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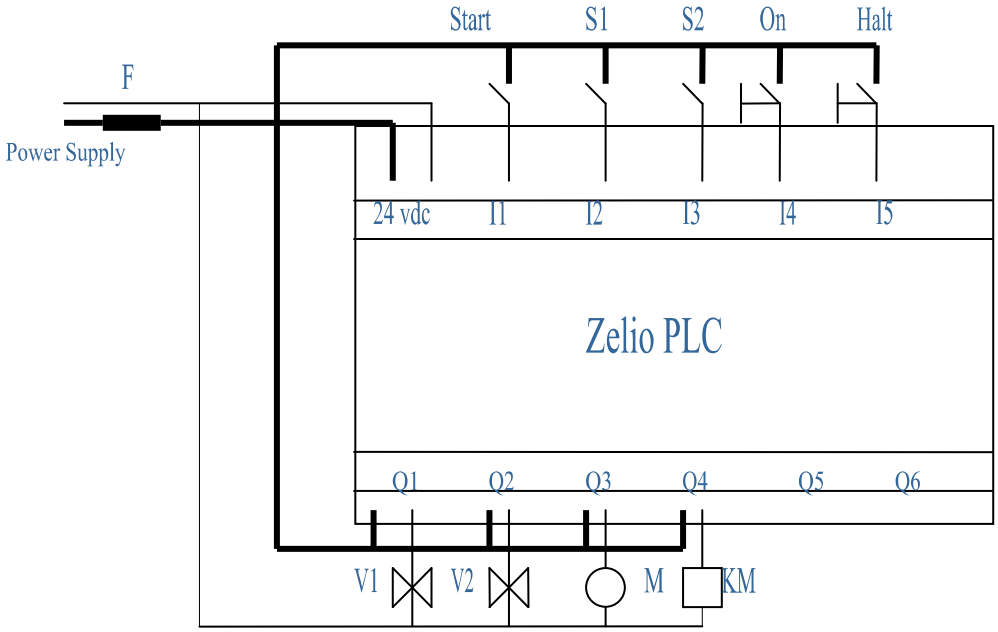
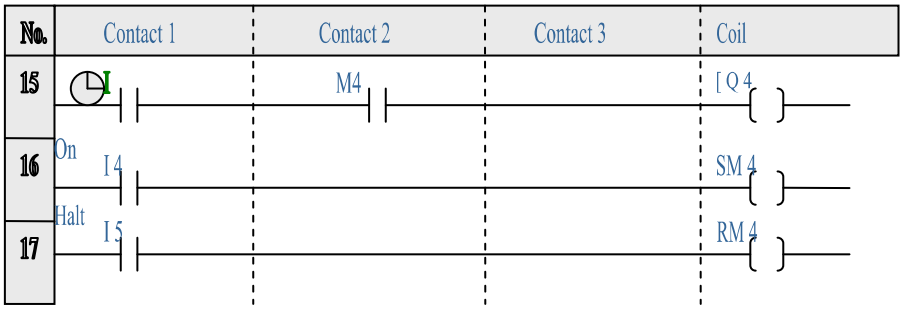


Figure 5



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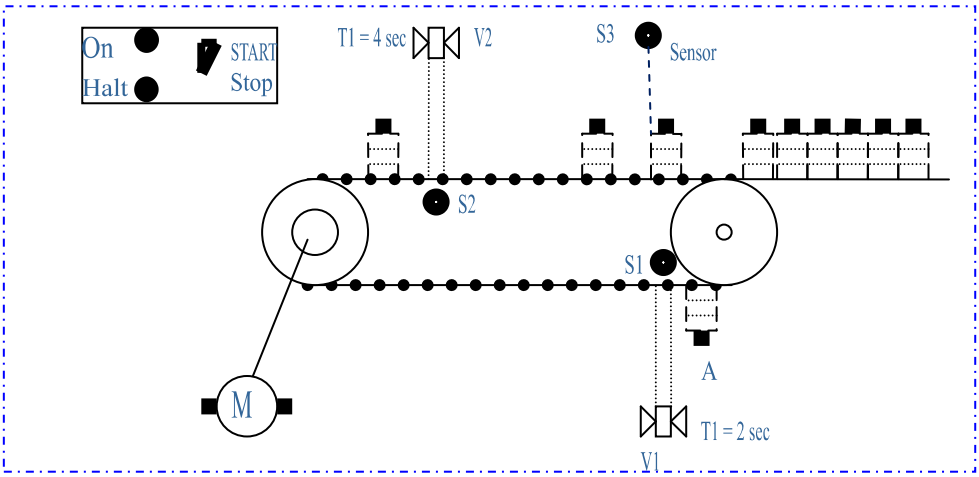


Figure 7

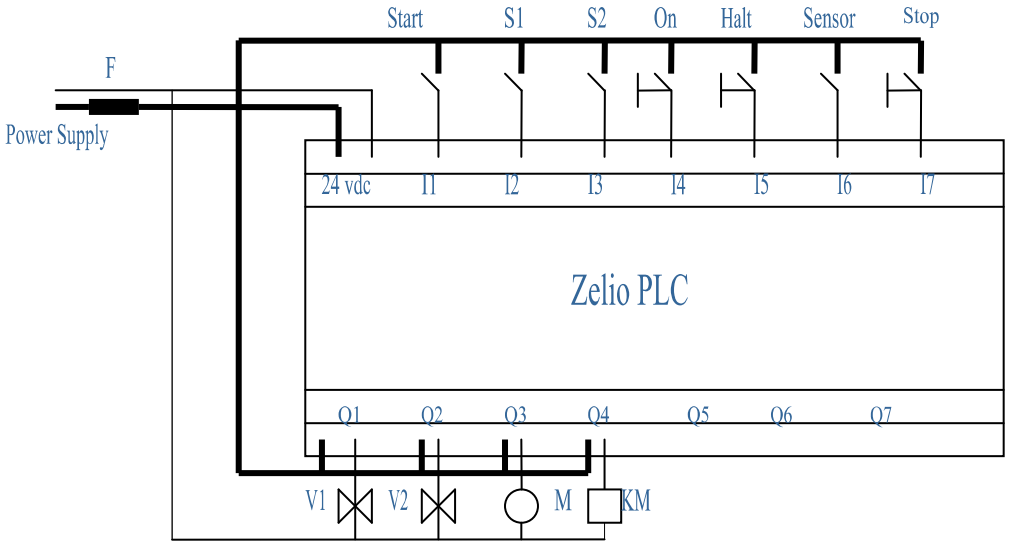
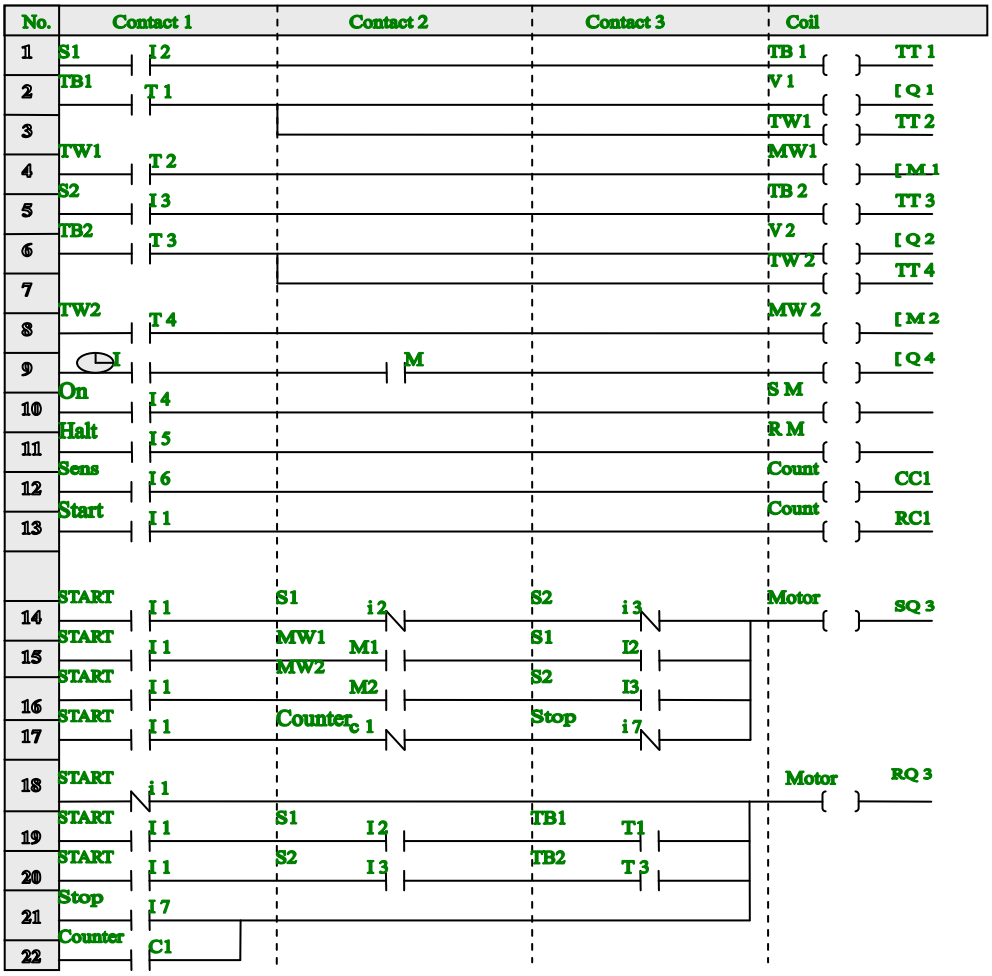


Figure 8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Contact 2
Contact 3
Coil
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2 TB1 T 1 V 1 [Q 1
3 TW1 TT 2
4 TW1 T 2 MW1 [M 1
5 S2 I 3 TB 2 TT 3
6 TB2 T 3 V 2 [Q 2
7 TW 2 TT 4
8 TW2 T 4 MW 2 [M 2
9 I M [Q 4
10 On I 4 S M
11 Halt I 5 R M
12 Sens I 6 Count CC1
13 Start I 1 Count RC1
14 START I 1 S1 i 2 S2 i 3 Motor SQ 3
15 START I 1 MW1 M1 S1 I2
16 START I 1 MW2 M2 S2 I3
17 START I 1 Counter C 1 Stop i 7
18 START i 1 Motor RQ 3
19 START I 1 S1 I 2 TB1 T1
20 START I 1 S2 I 3 TB2 T 3
21 Stop I 7
22 Counter C1

Figure 9